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Terminalia ivorensis (A. Chev.) Idigbo, Emire

Combretaceae Combretum family

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HABITAT

Native Range

Terminalia ivorensis, (A. Chve.), idigbo, is a large tree of natural forests and plantations in West Africa. The species is found growing in a band 200 to 300 km wide around the Gulf of Guinea from Guinea to Cameroon (*14*). The natural range does not quite reach the coast except in the extreme northern portion and again around the Ivory Coast (fig. 1). Within the range, it grows naturally in the primary and secondary evergreen and semideciduous forests (*8*). Although widely distributed, the tree is not very abundant in the natural forest (*22*). The species has also been successfully grown in trials in Brazil (*9*), Costa Rica (*5*), the Solomon Islands (*1*), Fiji (*38*). and Puerto Rico (fig. 2).

Climate

Idigbo requires a moist climate with well-distributed rainfall (*40*). Although it grows in areas of high rainfall in the natural range, Idigbo is more common in slightly drier zones (*33*). A minimum mean annual precipitation requirement of 1300 mm (*39*) probably determines the northern extent of the range in the progressively drier interior of Africa. The species sheds its leaves in synchrony with the dry season, which may last up to 2 months in drier parts of the range even though humidity seldom falls below 50 percent (*22*). The mean maximum temperature of the hottest month ranges from 26 to 30 °C, and the mean minimum temperature of the coldest ranges from 22 to 24 °C (*39*). Temperature extremes of 18 to 35 °C are also cited (*36*). Frosts are unknown in the natural habitat; however, cool temperatures may limit development. In one experiment with seedlings, short day lengths (11 hours) and cool nights (20 °C resulted in smaller leaves and slower growth (*22*).

Soils and Topography

Idigbo occurs mainly at low altitudes, 0 to 700 m (*39*), but one plantation at 1,200 m in Uganda has been successful (*40*). The species is not exacting in its soil requirements (*33*). Gravelly upland latisoils, sandy loam to clay loam alluvials, and andic soils are examples of suitable soils. Excessively dry sites such as coarse sands, shallow soils over bedrock or hardpan, and grasslands are unsuitable (*40*). Although idigbo can tolerate short-term flooding (*39*), it will not grow in poorly drained clays or swamps (*22, 33*). Slope and aspect are not usually important factors.

Associated Forest Cover

Idigbo is a seral species dependent on disturbance for successful establishment. Although it is found in the high forest, it is most abundant on reforested farmland and areas disturbed by logging (*6, 37*). The species is typical of the transition forest that lies between the evergreen and the deciduous forests. In the Liberian transition forest, idigbo occurs with *Chlorophora excelsa* (Welw.) Benth. & Hook., *Piptadenia africana* (Hook f.) Brenan, and several species of *Afzelia* (*15*). A list of trees greater than 30 cm in diameter at breast height (d.b.h.) that occurred with idigbo on one high forest site in southern Nigeria included: *Khaya ivorensis* A. Chev., *Lovoa trichilioides* Harms, *Entandophragma angolense* (Welw.) C. DC., *E. cylindricum* (Sprague) Sprague, *Guarea cedrata* (A. Chev.) Pellegr., *G. thompsonii* Sprague & Hutch., *Piptadeniastrum africanum* (Hook f.) Brenan, *Distemonathus*

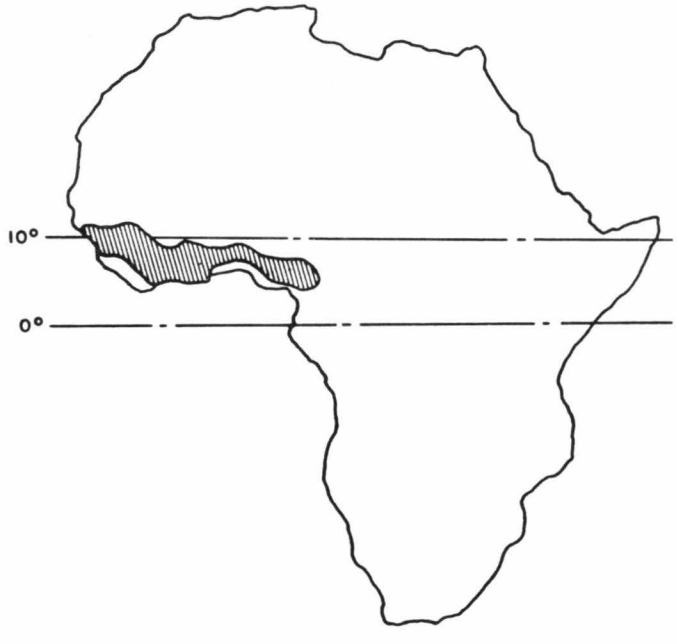

Figure 1.—*Distribution of* Terminalia ivorensis in *Africa.*

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benthamianus Baill., *Lophira alata* Banks ex, *Chlorophora excelsa* (Welw.) Benth. & Hook, and *Tripolochiton scleroxylon* K. Schum. (*23*). A count of saplings and poles 9 years after a tropical shelterwood treatment in the Idanre Forest Reserve, Nigeria, revealed the following associated species: *Afzelia* spp., *Entandophragma candollei* Harms, *Distemonanthus benthamianus* Baill., *Gossweilerodendron balsomiferum* (Verm.) Harms, *Guarea cedrata* (A. Chev.) Pellegr., *Khaya ivorensis* A. Chev., *Lovoa trichiliodes* Harms, and *Piptadeniastrum africanum* (Hook f.) Brenan (*10*).

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—The annual flush of new leaves emerges in April, and the inflorescences (*35*), which are axillary spikes with bisexual flowers, develop at the same time (*22*). Flowering continues throughout May and June (*37*). New fruits appear soon afterwards, but are not ripe until anywhere from December to February (*37, 35*). Fruits are generally shed along with the leaves in March. Some variation in this timetable occurs across the range of the species (*22*). In Puerto Rico, seedfall is in September.

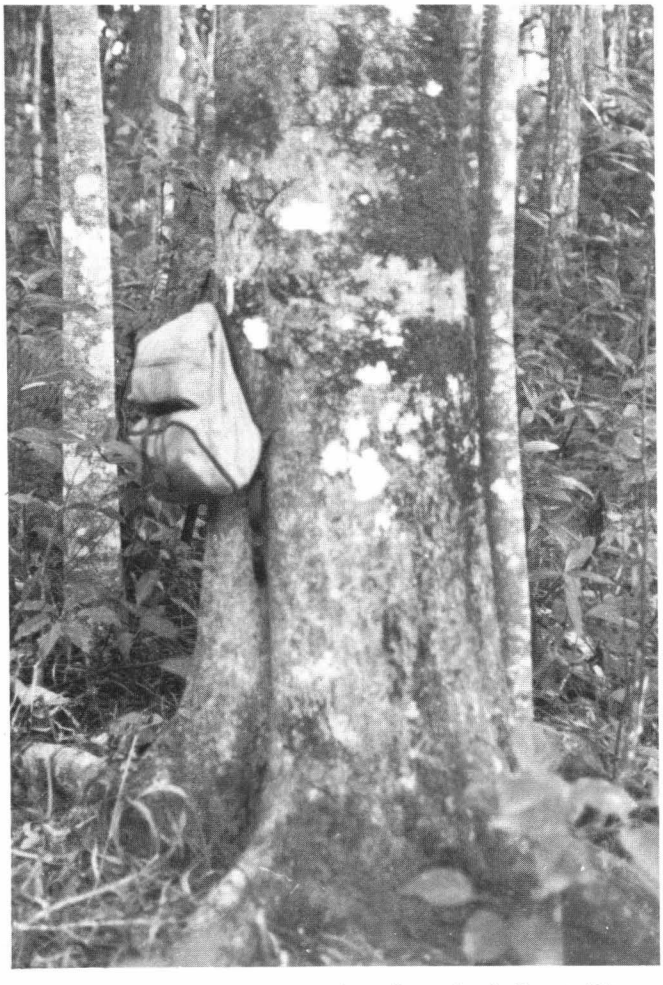

Figure 2.—*Indigbo tree growing in a plantation in Puerto Rico.*

The seeds, elongated samaras with wings extending the full circumference, are copiously produced. Idigbo begins flowering and fruiting when about 6 years old (*37*). The seeds average from 5,500 to 6,600 per kg (*33*). A sample from trees planted in Puerto Rico yielded 5,900 seeds/kg. The seeds descend with a tumbling action that carries them a short distance in still air. The seeds are eaten by small rodents, which may also carry the seeds to potential germination sites away from the mother tree.

Seed Production and Dissemination.—Germination, which is epigeal (*35*), may take from 14 to 49 days, and germination capacity varies from 25 to 50 percent (*22*). Investigation has revealed that the innermost layer of the pericarp slows the passage of water and contains an inhibitory endogenous growth substance (*4*). Germination can be accelerated by mechanical scarification or several cycles of soaking and drying followed by surface sowing under 12-hour light (*18*). The seed may be stored for up to 1 year if kept dry and cool in an airtight container (*39*). Otherwise the seed may lose its viability after 3 months (*35*).

Seedling Development.—Light shade is beneficial until the seedlings are well established (*22*). After cotyledons unfold, seedlings should be transplanted into individual containers or nursery beds. Spacing in the nursery bed should not be less than 30 by 30 cm because of the spreading branches that will develop. As the first true leaves mature, the shade should be removed because the species requires light. Planting stock may be developed as striplings (bare root seedlings with leaves removed), stumps (seedlings with the tops clipped off), or as containerized stock (in bags, pots, or baskets). Seedlings will be ready to outplant in 4 to 15 months (*39, 35*), depending on the size desired and the care they receive. Idigbo seedlings are drought-sensitive, so large containers and frequent watering are necessary, and planting (especially with bare root stock) should be timed to coincide with the wet season (*33, 35*). Under ideal conditions, there is little difference in the performance of stumps or containerized seedlings, but if conditions are less than ideal, particularly when planting late in the wet season, containerized stock will have better survival (*22*). The seedlings develop quickly, growing 2 m in height the first year when there is sufficient overhead light (*35*).

When site preparation has been adequate, closely spaced plantations have performed well (*22*). However, close spacing requires thinning, and a market for thinnings is not often available. There is also a problem with wide-spaced plantations because the trees may develop large knots and low-quality logs (*27*). Because of rapid growth and an eventual need for wide spacing, line planting (or enrichment planting) is a logical planting method that is often recommended (*33*). The method has been successfully used (*22*), even though idigbo is sensitive to shade and competition (*31*). Failures have apparently been due to poor maintenance after establishment (*22*). The species is suited to the taungya method, which has been used with reasonable success in several localities (*20, 34*). The problems encountered have been related to planting practice and quality of care given to the seedlings by farmers (*27*).

Vegetation Reproduction.—Idigbo will coppice when

young. Propagation by root cuttings has been successful (*11*), but air layering was not (*3*). Grafting is used to propagate material for tree breeding (*26*).

Sapling and Pole Stage to Maturity

Growth and Yield.—Idigbo is a very fast-growing species. It reportedly averages 1.8 to 2.1 m/yr until it reaches a 15-m height (*33*). In Uganda, rates of early height growth may vary from 1.2 to 4.9 m, while 2 to 3 m are common on good sites in Sierra Leone (*36*). Dominant trees may reach heights of 46 m and d.b.h.'s of 1.5 m (*22*). Idigbo trees are not long-lived, however (*35*). Harvestable trees with d.b.h.'s of about 1 m can be produced in plantations with rotations of 40 to 50 years (*31, 26, 16*). The best quality wood is obtained from trees 0.6 to 0.9 m in d.b.h. (*22*). Logs from larger trees have brittle heartwood, and smaller logs have a higher percentage of sapwood. Crop trees in three reserves in Ghana ranging from 13 to 23 cm in d.b.h. averaged 2.5 cm/yr of d.b.h. increment (*12*). The average measurements of a 24-year-old plantation in Puerto Rico were: height, 22.6 m; d.b.h., 31.5 cm; clear bole, 13 m; and survival, 51 percent. The tallest 20 percent of the survivors (crop trees) averaged 26.7 ± 0.5 m high and 42.5 ± 10.2 cm in d.b.h. On another site, 16 trees were planted in a mixture with several other species. The 12 surviving idigbo, also 24 years old, averaged 22.3 m tall and 26.7 cm in d.b.h. They were approximately the same height but smaller in diameter than *Pinus caribaea* Morelet and *Anthocephalus chinensis* (Lam.) A. Rich. ex Walp in the same planting. A plantation in Nigeria contained 420 m^3/ha when 24 years old (*16*), with a mean annual increment of 17.5 m^3/ha/yr. Other mean annual increment figures cited were 8.4 to 9.8 m^3/ha/yr for Nigeria and 3.5 to 7.4 m^3/ha/yr for Sierra Leone (*40*). Although individual tree growth is rapid, volume increment per area is low due to the large crown and wide spacing required by each tree (*22*).

The first idigbo plantations used fairly close spacings (1.8 by 1.8 m to 2.4 by 2.4 m), but idigbo grew slowly at these crowded spacings (*22*). For this reason, there was a change to wider spacings (3.7 by 3.7 m to 5.5 by 5.5 m) in plantations (*31, 25*). For line plantings, planting in lanes cut in natural forests, spacings of 6.7 m between lanes and 5 m within lanes have been used (*22*). Natural pruning in idigbo is rapid, so that clear boles for much of the trees' heights are produced without investment in artificial pruning. Boles are straight without excessive taper.

Rooting Habit.—The stem is buttressed and often fluted in the lower bole. Fluting is associated with large roots (*17*). Idigbo produces a taproot and six to eight thick lateral roots (*22*). There is evidence of a widespread and superficial root system, especially on poor sites. To avoid damage to shallow tree roots in Ghanian taungya plantations, farmers are required to plant yams at least 1.8 m away from the trees (*20*).

Reaction to Competition.—Idigbo is intolerant of shade and requires full overhead sunlight to develop (*22*). However, natural seedlings in Puerto Rico were able to attain heights of several meters when growing below the parent trees and under adjacent moderately low-density plantations of *Pinus* spp. Idigbo does not endure suppression, but given an equal start, it tends to overtop and suppress competing vegetation. The species may be suitable for mixed plantations with other very fast growing species, such as *Terminalia superba* Engl. & Diels and *Triplochiton scleroxylon* K. Schum. (*35*). Idigbo has been planted with more tolerant *Meliaceae* species, but the growth of *Meliaceae* was too slow for the planting to be economical (*11*). Natural regeneration of indigo is good where there is disturbance from shifting cultivation or logging (*22*). In certain situations, young idigbo trees may be smothered by vines until a new leader breaks through and develops a new layer of branches. Idigbo benefits from cleaning and tending operations. Basal areas of 8.3 to 34.2 m^2/ha are cited for idigbo in both pure and mixed stands (*16*). Basal area increments of 0.8 to 1.4 m^2/ha/yr have been recorded in young Nigerian plantations (*25*). A final crop of 99 trees/ha is considered more than adequate (*22*). Unfortunately, no stocking guides are given in terms of basal area; however, the optimum probably lies somewhere between 10 and 20 m^2/ha.

Damaging Agents.—A serious decline disease has become widespread in recent years in plantations of Ghana and the Ivory Coast. Pole and saw log trees are attacked, and eventually most of the trees in the affected plantations die. No specific pathogen has yet been identified (*30*). Although a large number of insects attack idigbo, none has yet had a serious impact on management except locally. A few of the more important insects are: the shoot borer, *Tidesmodes ramiculata* Warren; the bud borer, *Sphaerotrypes* sp.; the stem borers, *Apate monochamus* F. and *Zeuzera coffea* Nietner; the sucking bugs, *Cryptoflata* sp., *Otinonotus* sp., and *Tricoceps albescens* Funkh.; the seed weevil. *Nanophyes* sp.; and a large number of leaf-eating insects (*22*). The wood is susceptible to powderpost beetle (Lyctidae) attack (*2*). The resistance of idigbo to termites varies depending on the part of the tree the wood comes from (*28*). A canker caused by an unknown agent has been found at a high frequency on three sites in Southern Nigeria (*29*). Multinutrient fertilizer has shown promise as a cure for affected trees. Browsing damage by a small antelope, *Cephalopus maxwelli* Hamilton-Smith, may be severe in line planted stands where lines serve as pathways for the antelope (*22*). In Puerto Rico, much of the seed is eaten by mice. As young trees, idigbo is susceptible to fire and liable to break at the nodes when buffeted by winds (*22*). Although one source lists the species as having "good wind firmness" (*38*), other workers cite breakage in strong winds (*22*). The wood weathers well, but will not endure long when in contact with the ground. A cause for concern among foresters and millers is "brittle heart," a lighter weight (0.38 to 0.57 g/cm^3) and weaker wood associated with a pinkish color from the center of trees (*22*). No casual agent has been identified, but large, old trees are most often affected.

SPECIAL USES

The wood of idigbo is yellowish or light yellowish brown, with no clear distinction between the heartwood and sapwood but with distinct growth rings (*2*). The wood has a moderate amount of figure (aesthetic grain pattern)

and a high lustre. It is of medium but variable density (0.45 to 0.67 g/cm^3) (*22*). Idigbo timber seasons rapidly with little distortion or checking (*2*). Drying from green to 12-percent moisture content (air dry) results in a 3-percent tangential shrinkage and a 1.5-percent radial shrinkage. The strength properties of the wood have been published (*24*) and are very similar to mahogany (*21*). The wood is acidic and corrosive to iron nails and fittings (*2*). However, it works well with machine and hand tools. Idigbo wood is used for furniture, doors, framing, trim, structural lumber, and shingles (*32*). Tests show that the species is good for papermaking by the sulfate process, yielding an extremely strong paper that is bleachable to a moderate brightness (*7*). The timber is used for the production of veneer (*22*), and there seems to be no reason that could not be used for plywood and particleboard. In Africa, the species is used successfully as a shade tree for cocoa and coffee (*20*).

GENETICS

Idigbo is quite similar to a sister species, *Terminalia superba* Engl. & Diels. Although the ranges overlap and they often grow in association, idigbo tends to occur on drier and more disturbed sites. Idigbo is more frequently grown in plantations.

Provenance differences have been shown for idigbo (*8*). Selection to improve the species should focus on reducing fluting of the lower bole (*19*), reducing the crown ratio (*22*), and reducing the tendency for "brittle heart."

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